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# USSR Report

EARTH SCIENCES

No. 16



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USSR REPORT  
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## METEOROLOGY

### SOVIET-AMERICAN SYMPOSIUM ON EFFECT OF SOLAR ACTIVITY ON CLIMATE

Vilnius SOVETSKAYA LITVA in Russian 3 Jun 81 p 3

[Unsigned article: "Solar Activity and the Earth"]

[Abstract] A Soviet-American symposium on "Effect of Solar Activity on Climate" ended today at Vilnius. The outstanding scientists of the two countries represented a wide range of fields of specialization. Ye. Borisenkov, who headed the Soviet delegation (head of the Main Geophysical Observatory), pointed out that on the basis of observations made from artificial satellites and by other methods it has been possible to collect a great volume of valuable data on this subject. There has been an extensive exchange of data on the influence of solar activity on the behavior of the biosphere, on changes in the solar constant, on the orbital parameters of our planet, on the chemical composition of the stratosphere and on phenomena transpiring hundreds and thousands of years ago. Academician L. Kayryukhtis, a member of the Soviet delegation, chairman of the Dendrochronology Commission of the USSR Academy of Sciences, declared that the scientists of Soviet Lithuania have made a significant contribution to study of the factors exerting an influence on climatic change, having done much work under the program "Man and the Biosphere." Other Lithuanian representatives told about studies made of atmospheric contamination problems. On their part, American representatives emphasized that progress in this field requires the coordinated efforts and mutual understanding of scientists in all countries.

[185-5303]

UDC 911.2:551.58

### RELATIONSHIP BETWEEN SOME CLIMATIC FEATURES OF ANTARCTICA AND THE EARTH'S OUTER GRAVITATIONAL FIELD

Leningrad IZVESTIYA VSESOYUZNOGO GEOGRAFICHESKOGO OБSHCHESTVA in Russian  
Vol 112, No 6, Nov-Dec 80 pp 489-496

RUDYAYEV, F. I.

[Abstract] A nonuniformity in the distribution of gravity should be manifested in the nature of the mean long-term field of atmospheric pressure, especially in regions of significant gravity anomalies. The author has constructed a map illustrating the qualitative correlation between the frequency of recurrence of cyclones and gravitational field anomalies. It is shown that all of eastern Antarctica and the Palmer Peninsula are characterized by positive gravity anomalies. The Antarctic

continent is surrounded by a zone with negative anomalies. In the eastern sector of Antarctica this zone extends between parallels 60-70°S. In the western sector the region of negative anomalies, broadening, extends toward the South Pole. The greatest frequency of recurrence of cyclones is in the region of negative gravity anomalies. In regions of positive anomalies, on the other hand, the frequency of cyclones is negligible and the frequency of recurrence of anticyclones is greatest. It is a statistically established fact that cyclones correlate with negative anomalies and anticyclones correlate with positive anomalies. A map of anomalies in the Bouguer reduction shows that the elimination of the masses of Antarctic ice would result in the entire Antarctic continent having considerable negative gravity anomalies, especially in the eastern region, where the latter exceed -150 mgal. In part such great anomalies can be attributed to the isostatic subsidence of Antarctica under the load of accumulating ice. However, such subsidence would not be more than hundreds of meters, which could not substantially change the general character of the distribution of gravity anomalies in the Faye reduction. Therefore, if there was no ice cover in the region of modern Antarctica there would be considerable negative gravity anomalies. Such a gravitational field would favor increased cyclonic activity, especially in eastern Antarctica, where the greatest negative gravity values prevailed. The latter circumstance in turn was accompanied by the increased falling of precipitation. With the low temperatures in the coastal zone the precipitation fell in the form of snow, accumulating and compacting rapidly, covering the Antarctic islands and filling the water expanses between them; it can be postulated that this was responsible for the formation of the Antarctic continental glacier. As a result of the accumulation of ice masses and secular rising of the crust the greater part of Antarctica now has positive gravity values. It can be concluded that as time passed the replacement of negative gravity anomalies by positive anomalies resulted in the transformation of primarily cyclonic activity into anticyclonic activity (especially in eastern Antarctica). As a result, the further growth of the ice sheet was slowed. Figures 3; table 1; references 5:  
4 Russian, 1 Western.

[190-5303]

## OCEANOGRAPHY

### OCEAN CURRENTS STUDIED ON MARINE EXPEDITION

Riga SOVETSKAYA LATVIYA in Russian 5 Apr 81 p 4

[Interview with Candidate of Geographic Sciences L. Fomin in Moscow by TASS Correspondent S. Korepanov: "The Moon and Coriolis Forces"; date of interview not given]

[Text] The nature of the enigmatic internal waves of the ocean that are formed by underwater currents has become a subject of investigation by scientists of the Institute of Oceanology of the USSR Academy of Sciences. Candidate of Geographic Sciences L. Fomin, leader of the Indian Ocean Expedition of the Academy's research ship "Dmitriy Mendeleyev" tells our TASS correspondent about experiments conducted in the course of the expedition.

[Fomin] We studied one of the strongest underwater currents of the worldwide ocean, named in honor of the Soviet scientist Tareyev. Other known currents are the Cromwell current in the Pacific, and the Lomonosov current in the Atlantic. These deep streams form a gigantic underwater equatorial belt around our planet. Its formation is due to the general circulation of waters of the worldwide ocean and the so-called Coriolis forces set up by rotation of the earth about its axis. The globe of the earth twists the layers of the three oceans on the equator and produces deep westward moving currents. Surface currents however move in the opposite direction. Therefore there is a constant exchange of deep water and surface water on the equator.

The Tareyev current crosses the Indian Ocean along the equator from the African continent to Indonesia at depths of 250-300 meters. As scientists, we were interested primarily in the hydromechanical particulars of the current. The "Dmitriy Mendeleyev" placed buoy stations along a segment of the meridian extending for 900 km. This was necessary to study the structure of the transition layer from the surface to the countercurrent.

[Question] What is the role of internal waves in heat exchange of the worldwide ocean?

[Answer] Internal waves can be detected only by instruments. Their period of oscillations in the layers of the ocean is measured in minutes and even hours, and their height runs to hundreds of meters!

In studying the formation and interaction of these waves with surface waves, we managed to detect short internal waves with a period of 15-20 minutes and height

of 75-80 meters. Their interaction with surface waves causes "bubbling" strips on the ocean. This is evidence of active transfer of the energy of strata of the ocean to its surface.

[Question] What is the source from which internal waves draw their energy?

[Answer] Mainly from tides. Each day lunar gravitation sets the great cup of the worldwide ocean into oscillation. The resultant tidal waves transfer energy to the internal waves, and these in turn transfer energy to surface waves.

[Question] And further on to the atmosphere?

[Answer] Yes, everything here is interrelated. Our problem has been to define the internal waves from aboard a moving ship or airplane. Formerly such an investigation had to be done blindly, by instruments that were lowered into the ocean at different points. Now we will be able to do this more selectively, and hence more accurately.

[Question] What will the national economy gain from your research?

[Answer] Such results are of the greatest interest to fishermen. In zones of active interaction of internal and surface waves we find deep water rising that is rich with plankton; and where the plankton is, there will be fish.

Knowledge of the mechanism of formation of internal waves and their interaction with other oceanic movements will enable development of mathematical models of the state of the ocean and the distribution of energy in the sea, which is important for perfecting methods of weather forecasting on the planet.

6610  
CSO: 1865/171

## BETTER SONAR FORESEEN FROM OCEAN WATERS MOVEMENT DISCOVERY

Moscow VODNYY TRANSPORT in Russian 14 May 81 p 4

[Article by E. Prokhorenko: "Explorations and Discoveries, Thin-Layer Movement of Waters."]

[Text] A discovery in the area of oceanology has been registered under the number 240 at the USSR State Committee on Inventions and Discoveries. Corresponding Member of the USSR Academy of Sciences A. Monin, Doctor of Physical and Mathematical Sciences K. Fedorov, and Candidate of Technical Sciences V. Shevtsov have experimentally established the previously unknown phenomenon of thin-layer movement of open ocean waters.

Scientists have discovered an interesting phenomenon after analyzing data from direct measurements in the ocean. Translation of thin, vertically adjacent, layers of waters occurs in the open ocean which is stratified by density. Situated one above the other, the layers move at different velocities and in different and sometimes opposing directions. Their thickness varies between 10-30 meters. According to previous concepts, however, the range was considered to be 100-1,000 meters.

The moving layers differ from layer to layer in temperature, salinity and density. By depth, drastic changes in different physical parameters most often occur in the very same interlayers. The coincidence of high values of vertical gradients of density and translational velocity makes the thin-layer movement of water hydrodynamically stable. The overall current, both vertical and translational, carries with it the thin layers and the interlayers, which move differently in relation to one another.

"The discovered phenomenon makes it possible to view the structure and the interaction of the various types of movement in the ocean completely differently," observes K. Fedorov, one of the discoverers. "Concepts, which have existed until now, those concerning the transfer of energy from the surface of the ocean to its deep, those concerning the order of distribution in the mass of ocean waters, and those concerning the sources of energy of oceanic turbulence and benthic currents are changing. As far as the practical significance of the discovery is concerned, substantial improvement in the methods of underwater sonar is made possible. The thin-layer movement of waters phenomenon should be considered in calculations relating to the spreading of suspended matter and admixtures, including the toxic and the pollutant. This must be also taken into account when determining the spatial distribution characteristics in the ocean of plankton and other living organisms."

The discovery is one of the results of the implementation by the USSR Academy of Sciences' Institute of Oceanology imeni P. P. Shirshov of a broad research program concerning the turbulence, the translation and the thin structure of ocean waters. It is based on the laborious work performed in the Indian Ocean during one of the voyages of the scientific research ship "Dmitriy Mendeleyev."

Scientific investigations on the physical nature of the thin-layer movement of ocean waters and their role in various physical, chemical and biological processes occurring in the ocean deeps are continuing.

CSD: 1865/202-P

## FINNISH YARD BUILDS NEW RESEARCH SHIPS FOR USSR

Moscow VODNYY TRANSPORT in Russian 4 Apr 81 p 4

[Article by V. Borisov and B. Georgiyev: "The Akademik Shuleykin, the Akademik Shokal'skiy..."]

[Text] The development of our country's economy, in particular the North and Far East, and the development of reliable methods of forecasting weather and the navigation situation on navigation routes demand a knowledge of the hydrologic and ice conditions of the seas and their interaction with the atmosphere. The multifaceted activities of the expeditionary fleet of the USSR State Committee for Hydrometeorology plays an active part in solving many important scientific and practical problems. The fleet will soon receive some new ships.

The Finnish company Laivateollisuus in the city of Turku has built five scientific research vessels at its shipyard on order from the Soviet Union. These ships are designed for comprehensive study of the world ocean with respect to hydrometeorology and environmental monitoring. They will be able to operate in the tropical and polar latitudes. These ships can sail in any region and have an augmented ice rating. Each ship has a displacement of 2,000 tons, a 3,200-horsepower engine, a traveling speed of 14 knots, the ability to operate independently for 50 days, and a sailing range of 15,000 miles without visiting ports.

The crew and scientific personnel of an expeditionary motorship will include 66 seamen, scientists, and specialists. They will have at their disposal up-to-date machinery, devices, and systems, navigation and radio communications equipment, and 12 laboratories (among them hydrologic, meteorological, aerological, hydrochemical, and synoptic laboratories). The ships have central control posts for scientific observations, automated units for collecting and processing incoming information, and buoys that contain oceanographic and meteorological instruments.

The new scientific ships have been named in honor of outstanding Soviet scientists who made major contributions to the formation and development of Soviet oceanography. The first in the series will be the motorships Akademik Shuleykin and Akademik Shokal'skiy. The name of V. V. Shuleykin, a founder of marine physics,

is linked to major studies in the field of thermal interactions between the ocean, atmosphere, and land and expeditions to the Arctic and Atlantic. The Black Sea hydrophysical station in Crimea, which still exists today, was established at his initiative, as was the Marine Hydrophysical laboratory in Sevastopol', which later became an institute with the same field of study.

In his works honored academician Yu. M. Shokal'skiy demonstrated the close inter-relationship among processes and phenomena occurring in the ocean and the atmosphere. He headed projects to compile general geographic, marine, and other types of maps and worked on the problems of studying and developing the Northern Sea Route. His memory is preserved in the placenames of 12 geographic points in the Arctic and Antarctic. The other three ships have been given the names of Professor P. A. Molchanov, who laid the foundations of domestic aerology; Honored Scientist of the RSFSR S. P. Ahromov, the inventor and designer of the world's first radiosonde who holds a significant role in the formation of the Soviet school of synoptic meteorology; and, Professor B. P. Mul'tanovskiy, who worked on development of improved methods of long-range weather forecasting.

11,176  
CSO: 1829/259

UDC 550.344.42+532.592

FIRST REGISTRY OF TSUNAMIS IN THE OCEAN (TSUNAMI OF 23 FEBRUARY 1980 IN THE SOUTH KURILE ISLANDS)

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 257, No 5, 1981  
manuscript received 13 Aug 80 pp 1088-1092

DYKHAN, B. D., ZHAK, V. M., KULIKOV, Ye. A., DAPPO, S. S., MITROFANOV, V. N.,  
POPLAVSKIY, A. A., RODIONOV, A. V., SOLOV'YEV, S. L., corresponding member, USSR  
Academy of Sciences, and SHISHKIN, A. A., Sakhalin Multidiscipline Scientific  
Research Institute, Far Eastern Scientific Center of the USSR Academy of Sciences  
and Institute of Oceanology of the USSR Academy of Sciences

[Abstract] An earthquake with a magnitude  $M = 7.0$  occurred on 23 February 1980 at 0550 hours (GMT) to the southeast of the Lesser Kurile Islands. This resulted in a tsunami alarm being sounded for the southern part of the Kurile Islands. The earthquake epicenter was situated at the point  $43^{\circ} 4'N$ ,  $146^{\circ}E$  with a hypocentral depth 30-40 km. Judging from the aftershock epicenters, its focus extended to the southeast and probably was associated with one of the major transverse faults of the Kurile Islands. The earthquake generated a small tsunami which was registered by tide gages on coastal sectors from Iturup Island in the north to Honshu Island in the south. The relatively great extent of the region where the tsunami was registered was caused by an orientation of the greater axis of the focus orthogonal to the island arc since the direction of maximum radiation of a tsunami usually coincides with the direction of the lesser axis of the focus. The tsunami was also registered by a bottom tide gage an hour prior to approach of the waves to populated places. Personnel at the hydrophysical observatory were able to observe the entire process of passage of the tsunami over the bottom sensor. This was the first case when a tsunami was registered at a considerable distance from a coast. The sensor was situated at a depth of 113 m at a distance of 8 km to the south of Shikotan Island. Pressure (ocean level) variations are converted into frequency-modulated electric signals which are registered by a specially developed converter in analog form in three frequency ranges: wind waves and surf, tsunami waves and tides. The method for studying the spectral composition of level fluctuations over the oceanic observation point is briefly described. This first such registry of a tsunami wave in the ocean resulted in accurate prediction of wave height and direction. However, this event also demonstrated the need for a more thorough study of the resonance properties of the shelf and their influence on tsunamis with computation of the factors needed for conversions from the bottom tide gage to coastal points of interest. Figures 3; table 1; references: 6 Russian.

[181-5303]

UDC 551.465

## FILTERING OF GRAVITATIONAL WAVES IN THE EQUATIONS OF DYNAMICS OF OCEAN CURRENTS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 257, No 5, 1981  
manuscript received 4 Dec 80 pp 1235-1239

BERESTOV, A. L., Institute of Oceanology

[Abstract] In the theory of oceanic currents for the investigation of macroscale movements it is customary to employ: 1) the Boussinesq approximation, the replacement of density  $\rho$  everywhere, except for the term  $g\rho$  in the equation of vertical movement, by mean density  $\rho_0(z)$  and the writing of the continuity equation in the form  $\operatorname{div} u = 0$ ; 2) a quasistatic approximation, the replacement of the equation of vertical movement by a hydrostatic expression; 3) a traditional approximation, neglecting the horizontal component of the vector of angular velocity of the earth's rotation. In these approximations in the solutions of the equations of hydrodynamics there is filtering out of acoustic and inertial oscillations, but gravitational waves remain in a number of solutions. Sometimes the latter are filtered out by equating vertical velocity at the ocean surface to zero, but such an approximation filters out only the surface gravitational waves, leaving internal waves and also excludes macroscale sea level fluctuations associated with surges and corresponding barogradient currents. The author accordingly has developed an approach for remedying these shortcomings. A quasiholoidal approximation is described which filters out gravitational waves. This approximation can be used both outside the tropical zone and near the equator where a quasigeostrophic approximation loses validity. Although the velocities of ocean currents are described quite precisely by geostrophic expressions, with filtering-out of gravitational waves, such filtering of short-wave oscillations is stronger than in a quasiholoidal approximation: it also filters out synoptic eddies of a quite small size which are known to carry a considerable part of the energy of oceanic movements. A quasiholoidal approximation therefore is preferable. References: 3 Russian.

[181-5303]

UDC 528.952(210.5:268)

REVIEW OF FACTORS RESPONSIBLE FOR ERRORS IN REPRESENTATION OF BOTTOM RELIEF ON MARINE NAVIGATIONAL CHARTS OF THE SHELF

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: GEOLOGIYA, GEOGRAFIYA  
No 6, Issue 1, Mar 81 manuscript received 15 Nov 80 pp 117-122

KOTYUKH, A. A. and MOROZOV, B. N., Leningrad State University

[Abstract] Most of the various instrumental errors and different external distorting factors exerting an influence on the accuracy of depth measurements on the shelf, and accordingly affecting the quality of marine navigational charts, are already effectively taken into account and exert no significant influence on the product. However, there are a number of factors which constitute definite problems: fluctuations of sea level, especially under the influence of surges, deviations of the speed of sound in water from the computed value, variations in settling of the vessel during its movement in shallow water and the influence of sea bottom slope. The degree of influence of these distorting factors on the measurement results is dependent on specific conditions, especially sea depth and the nature of bottom relief. For example, the error in determining mean speed of sound in water is 0.3-0.5% of the measured depth and the "settling" error arising in measurements of shallow depths is 1 m. Rolling of the ship also exerts a definite influence on depth measurements. After reviewing these factors, the authors point out that an increase in the accuracy of bottom relief is dependent primarily on the instruments used in measuring depths, proper determination of speed of sound in water and sea level fluctuations and on the accuracy in coordinating depth measurements and other work procedures. The use of automation will facilitate improvements in depth measurements and will afford possibilities for introducing the latest data processing methods. References: 7 Russian.

[154-5303]

UDC 551.46.07(265.5)

JOINT PACIFIC OCEAN EXPEDITION OF THE SCIENTIFIC RESEARCH SHIP 'PEGAS' (18TH VOYAGE) AND THE SCIENTIFIC RESEARCH SHIP 'MORSKOY GEOFIZIK' (14TH VOYAGE)

Moscow OKEANOLOGIYA in Russian Vol 21, No 2, Mar-Apr 81 pp 394-396

ANOSOV, G. I., IL'YEV, A. Ya. and SUVOROV, A. A.

[Abstract] The 105-day Pacific Ocean Expedition of the Sakhalin Multidiscipline Scientific Research Institute ended on 25 April 1980. The expedition was implemented by two ships working under the international program for study of the active margin between the continents and oceans. The geological-geophysical work program included continuous seismic profiling by reflected and refracted waves, gravimetric

observations, heat flow measurements, echo sounding and dredging. The "Pegas" carried 29 scientific specialists and the "Morskoy Geofizik" carried 9. The ships left Korsakov on Sakhalin on 11 and 22 January 1980 and followed a track shown on a map accompanying the text, on which the work areas are also designated. Among the preliminary results of this expedition were the following. The regional geological-geophysical studies in three polygons covered an area of about 165,000 km<sup>2</sup>, including: in the zone of contact of the Kermadec and Tonga trenches 60,000 km<sup>2</sup>, in the "Vityaz'" trench 30,000 km<sup>2</sup> and over the Pacific Ocean platform 65,000 km<sup>2</sup>. A regional profile was also run between 13 and 26°N near the meridian 155°E. Seismic profiling by the reflected waves method was carried out over a distance of 24,253 running kilometers, and by the refracted waves method about 600 km. Gravimetric measurements were made over a distance of 11,500 km. Heat flow was measured at five points and dredging was accomplished at 18 stations. All observation lines and stations were reliably tied in by satellite. Echo soundings in combination with continuous seismic profiling provided much new data on bottom relief in the mentioned trenches. Reflected wave data yielded important information on the structure and stratification of the upper part of the sedimentary complex, dislocations in the sediments and outcropping of rocks of the acoustic basement. Refracted wave data made it possible to construct velocity sections for two polygons. Gravimetric measurements gave data on the distribution of the gravity field within the polygons and along the regional profile. The Δg curves for the observed gravity field correlate with forms of bottom relief. Specific details are given concerning some of these findings. Figures 1.

[153-5303]

UDC 551.462.681.1/4

#### EXPERIENCE IN USING A CORER GAMMA-DENSIMETER IN MARINE GEOLOGICAL STUDIES

Moscow OKEANOLOGIYA in Russian Vol 21, No 2, Mar-Apr 81 manuscript received  
15 Jan 79 pp 384-388

BLAZHCHISHIN, A. I., ZVOL'SKIY, S. T., SLOBODYANIK, V. M. and VOVK, P. K.,  
Atlantic Division, Institute of Oceanology of the USSR Academy of Sciences and  
Institute of Geological Sciences of the Ukrainian Academy of Sciences

[Abstract] There are a great number of shortcomings in traditional methods for shipboard determinations of the physicomechanical properties of bottom deposits removed from corers, the most important being that the sediment is deformed during extraction, which results in errors in analyses. For this reason specialists at the Institute of Geological Sciences Ukrainian Academy of Sciences have developed a corer gamma-densimeter which makes possible distortion-free density measurements. It is based on the attenuation of a collimated beam of gamma radiation of Cs<sup>137</sup> by the bottom deposits in the corer. The unit consists of a density sensor, scaler with connecting cable and control device. The source of γ-radiation is enclosed in a lead shield (collimator), where it remains during use, transport and storage.

The range of density measurement is  $1.0\text{-}2.3 \text{ g}\cdot\text{cm}^{-3}$ ; the measurement error is not more than  $\pm 0.04 \text{ g}\cdot\text{cm}^{-3}$ ; the a-c current supply is 220 V, 50 Hz; the density sensor measures  $204 \times 320 \times 276 \text{ mm}$  and weighs 22 kg. The instrument has been employed in different experimental variants on a number of expeditions and has given excellent results. Still unsolved is the problem of the degree to which bottom sediments are deformed with their entry into the corer. It is clear that large-scale measurements of density and other physical properties of sediments by radioisotopic methods will afford new possibilities for a lithostratigraphic breakdown of the sedimentary layer, for comprehension of diagenesis processes and for geological mapping. Figures 2; references 5: 4 Russian, 1 Western.

[153-5303]

UDC 551.465(266)

#### VARIABILITY OF HYDROPHYSICAL CHARACTERISTICS ON THE PERUVIAN SHELF

Moscow OKEANOLOGIYA in Russian Vol 21, No 2, Mar-Apr 81 manuscript received  
26 Nov 79 pp 229-238

POZDYNIN, V. D. and POYARKOV, S. G., Institute of Oceanology

[Abstract] During March 1978, under the program of the 20th voyage of the "Dmitriy Mendeleyev," intensive investigations were made of the variability of hydrophysical characteristics on the Peruvian shelf. The observations were made at a point where water depth was 65 m in the boundary zone between the Peruvian coastal current and the Peruvian countercurrent. Series of temperature and conductivity soundings were made each 4 hours with subsequent computation of salinity and density, with construction of their vertical profiles. Bathometer samples were taken at stipulated horizons for hydrochemical analyses. A BPV-2 current meter was used in measuring current direction and velocity at the horizons 15, 30, 45 and 60 m with a discreteness of 5 minutes. Table 1 gives data on the variability of the mean hourly values of hydrophysical characteristics at several horizons during the entire observation period; Table 2 gives the vertical gradients for layers with a thickness of 5 m (the greatest temperature gradients were at depths from 5 to 20 m, whereas the greatest salinity gradients were in the layer 0-15 m); Table 3 gives data on the variability of characteristics in a horizontal direction coinciding with the direction of the current; Table 4 provides data on the scatter of instantaneous values relative to their mean hourly values; Table 5 gives information on the relative variability of properties (the temperature field had the greatest variability and the salinity field had the minimum variability); Table 6 gives the characteristic dimensions of thermohaline inhomogeneities (inhomogeneities in all fields were in the upper 30-35-m layer, the zone of the greatest gradients of properties). It is shown that the variability of hydrophysical characteristics is associated for the most part with the horizontal transport of thermohaline inhomogeneities in the system of differently directed currents. Figures 3; tables 6; references 9: 7 Russian, 2 Western.

[153-5303]

UDC 551.463

METHOD FOR PROCESSING MEASUREMENT DATA ON MICROSTRUCTURE OF HYDROPHYSICAL FIELDS  
BY STD PROBES

Moscow OKEANOLOGIYA in Russian Vol 21, No 2, Mar-Apr 81 manuscript received  
29 Apr 80 pp 217-221

KORCHASKIN, N. N. and LOSOVATSKIY, I. D., Institute of Oceanology

[Abstract] At present studies of the fine vertical structure of hydrophysical fields are commonly made with CTD probes which give discrete readings of measured parameters with a uniform time interval. However, the resulting vertical temperature and conductivity (and related salinity and density) profiles often have a nonuniform vertical interval. Profiles of the fine structure of hydrophysical fields are often obtained by parabolic interpolation of series of hydrophysical data with use of Lagrange polynomials. The objective of this article is an analysis of the errors arising in such parabolic interpolation of field profiles obtained from CTD measurements. It was found that the errors in such computations increase considerably with an increase in the vertical gradient of the considered characteristic in the neighborhood of the interpolated point and also with an increase in the nonuniformity of siting of the measured points. An interpolation method is proposed which involves a "moving" approximation of individual parts of the initial profiles by polynomials of a stipulated degree. A comparison of the fine-structure temperature profiles computed by the two methods and a comparison of the corresponding spectra of vertical temperature inhomogeneities revealed that the new method is superior. Figure 1; references 5: 3 Russian, 2 Western.  
[153-5303]

UDC 551.465.11

NUMERICAL EXPERIMENTS FOR INVESTIGATING SYNOPTIC VARIABILITY OF OCEANIC  
MACROSCALE CIRCULATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 4, Apr 81 manuscript received 27 Feb 80 pp 408-418

SARKISYAN, A. S., SEIDOV, D. G., KNYSH, V. V. and RUSETSKIY, K. K., Institute of  
Oceanology of the USSR Academy of Sciences and Marine Hydrophysical Institute of  
the Ukrainian Academy of Sciences

[Abstract] In earlier studies by D. G. Seidov (IZV. AN SSSR, FAO, Vol 16, No 1,  
pp 73-87, 1980; Vol 14, No 7, pp 757-767, 1978) a model was proposed for computing  
macroscale oceanic currents with synoptic eddies taken into account. Continuing  
this work, a study is made of the role of the various factors involved in synop-  
tic dynamics of the ocean and the resultant effect of eddies on general circulation.  
The problem is formulated basically as follows. In a rectangular closed basin of

constant depth, in the  $\beta$ -plane approximation, currents develop and are sustained under the influence of a stationary wind and heat flow through the ocean surface. The wind is assumed to be zonal and the heat flow is assumed to be proportional to the temperature difference between the air and water. Among the conclusions drawn from the model and algorithm published earlier and the numerical computations presented here are the following. The configuration of the circulation plays a major role. The presence of a free "jet" leads to a dynamic regime which is fundamentally different than in the case of a single-ring circulation. In the case of intensive horizontal turbulence a large part of the received thermal energy and momentum is transported at subgrid scales and is then eliminated through the side boundary and bottom, leading to a rather smooth, climatic structure of a completely stationary circulation, this emphasizing the need for an explicit description of eddy transport with minimum possible turbulence at a subgrid scale. The heat flow is an extremely important factor. With a considerable meridional air temperature gradient the eddy-forming processes are intensified. A north-south asymmetry is observed in the case of a two-ring circulation with a "middle" jet. Two-layer models of macroscale circulation are extremely approximate because the deviations of the isopycnic surfaces are significant. In particular, the meridional asymmetry is characterized by a considerable north-south asymmetry of the vertical structure of waters. Eddies exhibit the properties of barotropic Rossby waves. A barotropization effect is observed as a result of strong nonlinear effects in the evolution of integral vorticity. Figures 8; tables 1; references 13: 6 Russian, 7 Western. [177-5303]

UDC 551.465.41

#### METHOD FOR COMPUTING THE TURBULENT REGIME IN A STRATIFIED OCEANIC BOUNDARY LAYER

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 4, Apr 81 manuscript received 23 Feb 79, after revision 30 Jun 80  
pp 392-399

SHVETS, M. Ye. and PONOMAREV, V. I., Main Geophysical Observatory

[Abstract] In the theoretical investigation of the turbulence regime in the oceanic boundary layer it is necessary to use not only the equation of motion and the equation for the balance of turbulent energy, but also the density transfer equation and the heat balance equation for the ocean surface. However, as the authors indicate, significant results on the characteristics of the turbulent boundary layer can be obtained by a priori stipulation of the density fluxes. On the basis of an asymptotic solution of the equations of motion, a method is proposed for computing the turbulent regime in the stratified boundary layer. Section 1 gives the fundamental equations and their solution; Section 2 gives the derivation of an equation for the function  $\psi$  ( $\psi = k/b$ , where  $k$  is the turbulent exchange

coefficient and  $b$  is the kinetic energy of turbulence); Section 3 is the derivation of an integral equation for the balance of turbulent energy; Section 4 is devoted to the case of neutral stratification. The modeling of the boundary layer is accomplished under the condition that the density flux in the quasihomogeneous layer of the ocean is a linear function of depth. A further development of the boundary layer model requires computation of the density fluxes and checking of the hypothesis of a linearity of the vertical profiles of these fluxes in the mixed layer. In addition, this method for computing the turbulent regime can be used in developing simplified models of the upper layer of the ocean for investigation of its interaction with the atmosphere. Figures 5; references 11: 10 Russian, 1 Western.  
[177-5303]

UDC 551.46.082:(528.47:629.472)

MEASUREMENT OF THE SPEED OF SOUND IN TOPOGRAPHIC SURVEYING OF THE SHELF

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 12, Dec 80 pp 37-39

BALANDIN, V. N., SERAVIN, G. N. and SOBOLEV, V. S.

[Abstract] It is essential to make precise measurements of the variability of the speed of sound in regions of topographic surveying on the shelf. It has been customary to use indirect methods for measuring the speed of sound on the shelf, but their inadequacies have forced the introduction of direct methods. These include both resonance and Doppler methods, but the methods which have gained the greatest acceptance are those based on a determination of the delay time  $t_{\text{delay}}$  of an acoustic signal traveling a known distance, the base  $d$ . Frequency, phase and pulsed variants can be distinguished and each are briefly described here. In pulsed methods  $t_{\text{delay}}$  of the received pulsed acoustic signal is determined relative to the moment of its radiation with a known base length. The pulsed-cyclic method is most promising due to its simplicity and reliability. It is based on measurement of the repetition rate of generator pulses: each successive pulse, passing through the investigated medium, triggers or synchronizes the next pulse. This method is evidently the most popular abroad. The technical specifications of some foreign and Soviet pulsed-cyclic units for measuring the speed of sound are listed in a table. In this article the operating principle for a pulsed-cyclic unit for measuring the speed of sound is examined on the basis of its block diagram. The required accuracy in measuring the speed of sound is determined by the minimum value of the correction which must be taken into account in a topographic survey of the shelf. Pulsed-cyclic systems have errors not exceeding 0.1%. These instruments appear to be the best for measuring the speed of sound at sea with respect to accuracy, reliability and effectiveness. Figures 3; tables 1; references: 2 Russian.  
[168-5303]

GEOLOGICAL HISTORY OF THE SOUTH ATLANTIC: 71st VOYAGE OF THE 'GLOMAR CHALLENGER'

Moscow PRIRODA in Russian No 4, Apr 81 pp 94-96

KRASHENINNIKOV, V. A., doctor of geological and mineralogical sciences, Geological Institute of the USSR Academy of Sciences, and BASOV, I. A., candidate of geographical sciences, Lithology Institute of the USSR Academy of Sciences

[Abstract] The 71st voyage of the "Glomar Challenger" began on 5 January 1980 at Vladivostok and became the first of five voyages under the current program for drilling in the South Atlantic. Specialists from the United States, USSR, West Germany, Great Britain, France and Canada participated in the expedition. The program provided for drilling in the southwestern Atlantic Ocean for the purpose of studying the Late Mesozoic and Cenozoic history of this region. Among the four holes drilled on the cruise, two were situated on the Falkland plateau (holes 511, 512) and two were on the western slope of the Mid-Atlantic Ridge, east of the Argentinian basin (holes 513, 514). It is believed that the Falkland plateau is a microcontinent which was formed approximately 127 million years ago when it was split off from Gondwana. After splitting off of southern Africa, it apparently drifted westward with the spreading of the Atlantic Ocean. It subsided at the same time. Hole 511 was drilled in order to reconstruct the long and complex history of its subsidence and the accumulation of sediments. This also made it possible to reconstruct the pattern of ancient currents, especially the development and migration of the Circumantarctic Current, and the opening and closing of Drake Passage. Hole 512 was drilled on the plateau for studying the history of accumulation of sediments and their subsequent erosion. Four breaks in sedimentation were detected, each corresponding to periods of intensification of the Circumantarctic Current. The composition of microfauna and microflora is evidence of a replacement of temperature climatic conditions in the Middle Eocene by more severe conditions in the Middle-Late Miocene. The drilling of holes 513 and 514 will help in answering such questions as: When was the Antarctic ice shield formed? How did its formation come about? Did its dimensions change or remain constant? The holes are in the neighborhood of the Antarctic convergence and cores taken from the bottom indicate that the convergence zone was formed in the Middle-Late Paleogene. These and other findings will make it possible to trace the history of geological development of the South Atlantic. Figures 2.

[164-5303]

UDC 551.551.2:551.524.1(262.8)

## MESOSCALE TEMPERATURE FLUCTUATIONS IN THE NEAR-WATER ATMOSPHERIC LAYER

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 5, May 81 manuscript received 15 Sep 80 pp 470-477

ALIYEV, A. S., Caspian Scientific Research Above-Water Station

[Abstract] The results of two-year measurements of the structural characteristic of the temperature field  $C_T^2$  are discussed. The measurements were made at the Caspian Scientific Research Above-Water Station, situated in the Caspian Sea near Baku, approximately 10 miles northeast of Artem Island. This is a steel platform of rectangular shape measuring 60 x 20 m. The platform was constructed on piles and rises 12 m above the water surface. It is oriented in the direction of the prevailing winds (approximately N-S); the sea depth under the platform is approximately 40 m. It was found that in the near-water layer, in contrast to the near-ground layer of the atmosphere, the universal dependence of  $a^2$  on  $Ri^*$  cannot be obtained. The structural characteristic of the temperature layer  $C_T^2$  in the near-water layer is essentially dependent on the water-air temperature difference and the height of measurements and to a lesser degree on the conditions for wave development. In the near-water layer  $C_T^2$  varies exponentially with height and the exponent is essentially dependent on stratification conditions over the sea. It was possible to derive an empirical universal dependence of  $A^2$  on  $Ri^*$  which makes it possible to determine the  $C_T^2$  value on the basis of the external parameters of the near-water layer. This universal function coincides well in form with the similar universal function obtained for the near-ground atmospheric layer. Figures 5; references 15: 13 Russian, 2 Western.

[193-5303]

UDC 551.466.81

## BEHAVIOR OF INTERNAL GRAVITATIONAL WAVES IN THE REGION OF CRITICAL LATITUDES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 5, May 81 manuscript received 1 Feb 80 pp 495-501

ABRAMOV, A. A., AKIVIS, T. M., IVANOV, Yu. A. and UL'YANOVA, V. I., Institute of Oceanology

[Abstract] The principal characteristics of the experimental spectra of fluctuations of currents and temperature in a wide frequency range are clearly expressed spectral density bursts at the tidal and inertial frequencies. This article presents a model describing the intensification of internal gravitational waves in the region of critical (limiting) latitudes, that is, those for which the characteristic wave frequency coincides with the Coriolis frequency. Disturbances with an inertial frequency can be of two types. The first type is characterized by spectral density bursts for the velocity components, with virtually no bursts for the spectra of the velocity modulus and temperature. The second type may be caused by peculiarities in the behavior of internal gravitational waves in the region of limiting latitudes.

The model was especially formulated in an effort to confirm the reasons for existence of the second type of disturbance and the model was found to be adequate for explaining the origin of inertial oscillations on the basis of the behavior of internal gravitational waves at these latitudes. Due to changes in the length of the propagating waves the horizontal coherence cannot be high; at the inertial frequency the magnitude of the spectral density burst can vary with time (intermittence). This is attributable to the fact that in the region of limiting latitudes there is a real possibility for the propagation of wave packets with different sets of wave numbers. Figures 3; references 13: 9 Russian, 4 Western.

[193-5303]

UDC 551.465.41

#### STRUCTURE OF THE OCEANIC SURFACE LAYER

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 5, May 81 manuscript received 8 Jan 80, after revision 9 Apr 80  
pp 521-526

VOROPAYEV, S. I., GAVRILIN, B. L. and ZATSEPIN, A. G., Institute of Oceanology

[Abstract] Solar radiation, absorbed in the surface layer of the ocean, heats the water, which lessens potential stratification energy. Wind-wave mixing, on the other hand, increases this energy. For this reason the authors sought to estimate the equilibrium wind velocity at which the decrease in potential stratification energy due to solar heating is balanced by its increase due to mixing and to compare these estimates with observational data. A physical model is presented which describes the processes which can transpire in the surface (10-15 m) layer of the ocean with simultaneous solar heating and wind mixing. Estimates are given for a number of parameters. Comparison was with observational data obtained on the 2d voyage of the scientific research ship "Professor Shtokman" in the equatorial Atlantic. It is shown that directly beneath the layer of collapse of wind waves there can be formation of an intermediate layer of stably stratified fluid which exerts a significant influence on the dynamics of energy transfer from the atmosphere into the ocean. The thickness of the layer of collapsing waves is about 0.5 m; the thickness of the formed intermediate layer of stably stratified fluid is about 10-15 m. Actual measurements confirm validity of the model. Figures 4; references 9: 5 Russian, 4 Western.

[193-5303]

UDC 551.465.152

## INVESTIGATION OF MICROSTRUCTURE OF OCEANIC HYDROPHYSICAL FIELDS USING A FREELY SLIDING PROBE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 5, May 81 manuscript received 19 Nov 79, after revision 1 Aug 80  
pp 527-536

KORCHASHKIN, N. N., LOZOVARATSKIY, I. D. and PLUZHNIKOV, V. M., Institute of Oceanology and Moscow Physical Engineering Institute

[Abstract] The article describes the operating principle and gives the principal specifications of sensors of an induction-type instrument for measuring the microstructure of hydrophysical fields in the ocean. The described probe freely slides along a cable. This "Vertikal'" sounding complex (the article is accompanied by a photograph and block diagram) was employed during the 22d voyage of the scientific research ship "Dmitriy Mendeleev" for repeated measurements of the fine structure of hydrophysical fields in different regions of the Pacific and Indian Oceans. The rate of sounding can be varied from 0 to  $4.5 \text{ m} \cdot \text{sec}^{-1}$  and hydrophysical characteristics can be measured during both descent and raising of the probe. The principal sensors are for pressure, temperature and conductivity. The measurement data obtained with such a probe are free of the distorting influences of the ship's rolling. There are still other advantages in comparison with the commonly used temperature-salinity probes. The data collected with this apparatus made it possible to compute the statistical characteristics of vertical nonuniformities of the temperature field. The spectrum of temperature inhomogeneities  $S_T(k)$  was obtained in a wide range of wave numbers  $k$  from 1 to  $10^{-4} \text{ cm}^{-1}$ , which is described well by known universal expressions. However, in individual cases, characterized, for example, by small amplitudes of internal waves in the thermocline, the  $S_T(k)$  spectra in the fine-structure interval differ appreciably from the universal curves and at scales of about 1 m have a significant spectral density minimum. Figures 5; table 1; references 11: 7 Russian, 4 Western.

[193-5303]

UDC 551.521.3

## AIRCRAFT INVESTIGATIONS OF SKY TRANSPARENCY AND BRIGHTNESS OVER THE SEA

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 5, May 81 manuscript received 4 Jun 79, after revision 1 Feb 80  
pp 547-550

BADAYEV, V. V., KOZLOV, Ye. M. and CHERNYSHOV, V. N., Institute of Oceanology

[Abstract] A great number of studies have been devoted to surface-level investigations of the scattering indicatrix and its interrelationship to aerosol optical thicknesses; most such studies have been for the altitude region 5-30 km, where

being few such measurements below 5 km and with an almost total lack of such data over the seas and oceans. This article gives some results of aircraft (Il-14) measurements of the brightness indicatrix and atmospheric transparency obtained at altitudes from 50 m to 3 km over the Black Sea and Sea of Azov in the spring of 1975 and the summer of 1978 simultaneously in the spectral ranges 0.45, 0.55 and 0.74  $\mu$ m. Observations of sky brightness were made during aircraft maneuvers with a constant banking angle. The design of the instrument and the geometry of the observations limited the range of measurements to the range of angles 15-140°. The angular resolution of the indicatrices is 3° and the relative measurement errors are 5%. On the basis of these measurements it was possible to derive expressions for the correlation between the brightness indicatrix and aerosol optical thicknesses in different parts of the spectrum which can be useful in solving problems in remote sensing of the optical characteristics of the water surface from space. Specific examples of application of these formulas are given. Figures 3; table 1; references 15: 14 Russian, 1 Western.

[193-5303]

#### 'KELDYSH' RETURNS TO PORT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Jun 81 p 3

[Abstract] The oceanographic research vessel "Akademik Mstislav Keldysh" has returned to the port of Kaliningrad. During its cruise, scientists aboard the ship investigated the possibility of long term weather prediction, and much attention was allotted to creating foundations for a theory of climate. The oceanologists were especially interested in the heat exchange between ocean and atmosphere within the Bermuda Triangle, a very energy-active zone of the ocean. While studying the relief of the ocean's bottom, the scientists discovered an underwater mountain with a height of about 1000 meters. It was bestowed with the name "Mstislav Keldysh." Responding to a request of the Institute of Oceanology of the Republic of Cuba, the scientists investigated the hydrological regimes of gulfs in the Caribbean Sea. Processing of the collected data made it possible for Cuban fisherman to discover very promising regions for the fishing industry.

[198-P]

SPECTRA OF POLYMODE CURRENTS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 258, No 2, 1981  
manuscript received 2 Feb 81 pp 331-334

DROZDOV, V. N., MONIN, A. S., corresponding member, USSR Academy of Sciences, and  
YUSHINA, I. G., Institute of Oceanology

[Abstract] In accordance with the Soviet-American POLYMODE experiment a number of institutes of the USSR Academy of Sciences and the Ukrainian Academy of Sciences made long-term measurements of oceanographic parameters in the Bermuda Triangle in the Sargasso Sea in an area measuring 300 x 300 km with its center at the point 29°N, 70°W during a 13-month period July 1977-August 1978. Most of these current measurements were made at 19 anchored buoy stations with measuring instruments at the four depths 100, 400, 700 and 1400 m. With a frequency of registry of currents of 3-4 readings per hour it was possible to accumulate about  $3 \cdot 10^{-6}$  values of the current velocity vector. There was registry of 21 synoptic eddies with diameters of 150-300 km with velocities of rotation in the upper layers averaging 30-35 cm/sec and rates of movement of 3-10 km/day primarily to the west and also a series of smaller eddies. These data made it possible to compute the energy spectra  $\omega E(\omega)$  (in  $\text{cm}^2/\text{sec}^2$ ), where  $\omega$  is frequency (in cycles/hour) and  $E(\omega)$  is spectral density. It was found that all 152 u and v spectra at four depths at 19 buoy stations in general have an extremely similar form with three distinct maxima in the neighborhood of the periods of synoptic eddies (averaging  $\tau = 1365.3$  hours  $\approx 56.9$  days), diurnal and semidiurnal tidal periods (averaging  $\tau = 24.7$  and 12.6 hours), separated by deep minima at periods about 57.7 and 14.2 hours and with a minimum directly after the semidiurnal period ( $\tau \approx 11.9$  hours). The v spectra were usually a little higher than the u spectra. Comparison of the spectra at individual buoys with the mean spectra indicated that usually a buoy is characterized by increased or reduced values of the spectra simultaneously at all periods and at all depths. The highest levels of the spectra were observed in the northwestern corner of the polygon, in the immediate neighborhood of the Gulf Stream, whereas the lowest levels were observed in the southwestern and especially in the northeastern corners of the polygon. Figure 1; table 1; references: 3 Russian.

[196-5303]

## NEW ULTRASONIC APPARATUS

Moscow VECHERNYAYA MOSKVA in Russian 2 Jul 81 p 1

[Abstract] Moscow specialists of the Central Scientific-Research Institute of Geodesy, Aerial Photography, and Cartography have created a scanning-searching sonar that can photograph the sea bottom down to a depth of 200 meters. The antenna, which is similar in appearance to "two welded metal pencils pointed at both ends," is towed behind a ship. The apparatus itself consists of several compact metal boxes mounted on the ship. The antenna slides along the surface and sends fan-like, ultrasonic impulses into the depths of the ocean. The signals are reflected from the bottom and transformed into video images. These images can also be recorded on videotape. The apparatus makes it possible to image the sea bottom even in the murkiest of conditions. The apparatus can scan an area with a width of 700 meters. It has already been tested in the Far East, Black Sea, and Caspian Sea, and it is now returning to the Far East.

[204-P]

## ALL-UNION CONFERENCE ON SUBMERSIBLES

Moscow NEDELYA in Russian 11-17 May 81 pp 8-9

[Abstract] At an All-Union Conference on Underwater Robot Equipment in Gelendzhik, which was organized by the Southern Division of the Institute of Oceanology of the USSR Academy of Sciences, plans for the "Argus" and the newly created "Manta 1.5" were discussed. The "Argus" is a manned submersible that carries a crew of three and moves at 2 to 3 knots. The "Manta 1.5," which was created by the Department of Equipment for Underwater Research, is a large, ray-like, unmanned submersible. It is equipped to take water and bottom samples, to receive photo and television imaging of the sea bottom, and to conduct search and rescue work. An attempt will be made to join the two submersibles this summer. The "Argus" will lie on the bottom and the "Manta" will try to find it and link-up.

At the Southern Division the "Krolik" hyperbaric complex can simulate depths down to 350 meters. On May 11 an experiment was begun with the goals of improving the effectiveness of working at depths and finding the most optimum relationship among the components of the breathing mixture. Employees of the Institute of Medical-Biological Problems will stay and work in the "Krolik" for a month under tens of atmospheric pressure.

[203-P]

TERRESTRIAL GEOPHYSICS

UDC 550.341+550.834

DETERMINATION OF THREE-DIMENSIONAL RADIATING AND REFLECTING OBJECTS FROM THE WAVE FIELD KNOWN IN A PLANE APERTURE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 257, No 5, 1981  
manuscript received 10 Nov 80 pp 1086-1088

ALEKSEYEV, A. S., corresponding member, USSR Academy of Sciences, VINOGRADOV, S. P., TSIBUL'CHIK, G. M. and CHEVERDA, V. A., Computation Center of the Siberian Department of the USSR Academy of Sciences

[Abstract] In the interpretation of seismic observations it is usually necessary to ascertain the internal structure of the medium from the free-surface oscillations caused by the action of some sources. The wave equation is the simplest means for a relatively good description of seismic wave propagation. For this reason solution of the inverse problem for the wave equation, that is, the problem of determining a diffracting or reflecting object  $\mathcal{O}_0$  from a wave field known at the free surface, is of great practical importance. The visualization of wave fields method has now gained great popularity. In this method the free-surface oscillations are assumed to be caused by some secondary sources and accordingly the initial problem of finding the object  $\mathcal{O}_0$  is replaced by the problem of determining some secondary radiating object  $\mathcal{O}_1$ . This gives rise to the question of the existence of  $\mathcal{O}_1$  and its relationship to  $\mathcal{O}_0$ . With this serving as their point of departure, the authors present theoretical considerations and computations which demonstrate that for a source-receiver observation system the determination of the reflecting boundary in a shortwave approximation is reduced to a determination of secondary sources concentrated in the immediate neighborhood of this discontinuity. Figures 2; references: 2 Russian.  
[181-5303]

STATISTICAL ALGORITHMS FOR DELINEATION AND CLASSIFICATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 4, Apr 81  
manuscript received 30 Jul 79 pp 58-71

GOL'TSMAN, F. M., Leningrad State University

[Abstract] The author proposes a general scheme for formulating algorithms for delineation of geophysical features on the basis of a set of numerical criteria stipulated at arbitrary points of three-dimensional physical space. The classification of features is a special case of delineation with the following assumptions: the values of the criteria are related to some class regardless of at what point in space they are determined and at what point in observation space there is stipulation of a very definite, unique set of values of the criteria for a particular feature. The theory and algorithms which are discussed are a generalization and further development of correlation delineation methods and cluster classification methods discussed earlier in the literature. The article outlines a unified scheme taking in a great number of different modifications of delineation and classification algorithms. The evaluation and recognition problems are solved successively in each such algorithm. Although individual solutions are obtained using an optimum scheme, in general the algorithms are not optimum and for the most part conform to the requirements of practical feasibility. The principal elements of the proposed delineation (classification) algorithms are: choice of the initial base values of criteria for features (classes), prediction of the anticipated values of criteria at points to be tested, determination of the values of "response" functions for solving the problem of whether the values of the criteria to be tested belong to the base sets. Each of the elements, depending on additional a priori data on the properties of the features to be delineated (classified), has a great number of modifications. To this are added different variants of the external organization of the algorithms, such as successive or joint delineation (classification) of groups of features, the number of which may be known or not know. Since a single article cannot give a sufficiently detailed description of the entire system of algorithms, the presentation is limited to an analysis of typical computation schemes and the most important modifications. These schemes can serve as a basis for formulating specific algorithms for the solution of practical problems. Figures 4; tables 4; references 12: 10 Russian, 2 Western.

[175-5303]

UDC 528.27

DEFORMATION OF PENDULUM KNIFE-EDGE SHAPE AS A SOURCE OF SYSTEMATIC ERRORS IN  
RELATIVE GRAVITY DETERMINATIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 4, Apr 81  
manuscript received 9 Jun 80 pp 79-82

ROMANYUK, V. A., Institute of Physics of the Earth

[Abstract] The author investigated the effect of a change in the geometrical configuration of a pendulum knife edge (its curvature radius) on the results of relative gravity determinations. It is noted that there are no references to this subject in the literature. The theoretical examination and computations presented here show that deformation of pendulum knife-edge configuration is the principal source of random and systematic errors in relative highly precise gravity determinations with a pendulum instrument. That part of deformation of pendulum knife-edge shape which is proportional to pendulum weight or gravity is responsible for deviation of the pendulum scale factor from unity. It is clear that in highly precise relative determinations of gravity with a pendulum instrument it is necessary to ascertain its scale factor at points of a wide-range standard gravimetric base. The formulas derived and the evaluations made in this article reveal that the pendulum knife-edge shape must have an exceptionally high stability and its deformations must not exceed thousandths or even millionths of a micron (the latter value is tens of times less than the dimension of an atom). This requirement is the only restriction limiting the attainable accuracy of relative pendulum gravity determinations.

Figures 1; table 1; references 7: 4 Russian, 3 Western.

[175-5303]

UDC 517.947

INVERSE PROBLEM IN THE DIFFRACTION OF ACOUSTIC WAVES AND VISUALIZATIONS AND WAVE  
MIGRATION METHODS

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 1, Jan 81 manuscript received  
15 May 80 pp 111-118

ALEKSEYEV, A. S., KREMLEV, A. N. and ZHERNYAK, G. F., Computation Center, Siberian  
Department of the USSR Academy of Sciences

[Abstract] A new method is proposed for solving the inverse problem of determining small velocity variations in a medium registered on the observation plane. The approach to a solution proposed here makes possible a discussion of the relationships among the wave field migration method, visualization of the density of secondary sources method and the method of solution of the inverse dynamic problem for the wave equation. The first section of the article gives a solution of the problem of

reconstruction of the density of sources, obtained by the Fourier transform method. Such a solution appears to be the simplest and also makes possible a detailed comparison of the wave migration and visualization of objects method. In the second section, the problem of determining velocity variations from the scattered field also essentially involves reconstruction of the density of pulsed sources. All this makes possible an objective evaluation of the resolution of different processing methods for the particular field observation and excitation system employed. The algorithm set forth in this article for solution of the inverse problem makes possible evaluations of resolution of this type for different formulations of the problem; both theoretical and numerical evaluations are given here as illustrations. Figures 2; references 8: 5 Russian, 3 Western.

[139-5303]

UDC 550.341/.834

#### SOLUTION OF SOME INVERSE PROBLEMS FOR THE WAVE EQUATION BY THE VISUALIZATION OF SOURCES METHOD

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 2, Feb 81 manuscript received  
26 Mar 80 pp 109-119

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[Abstract] Algorithms for visualization of the wave field, similar to image formation procedures in optical instruments, have come into use in seismics. Practical application of such an approach with solution of inverse problems in wave propagation theory has shown that the visualization algorithm is in reality a solution of the inverse dynamic problem of restoration of initial Cauchy data, playing the role of instantaneously incorporated sources, not giving a solution for the inverse problem of wave diffraction or scattering. In seismic prospecting it is important to be able to reconstruct the properties of the medium (wave velocities, discontinuities, etc.), not the distribution of fictitious sources, which may contain the sought-for information concerning the medium, but in coded form. Therefore, in this paper, on the basis of a scalar wave equation, the author demonstrates that with some restrictions imposed on the classes of media and rigorous requirements imposed on the methods for the excitation and reception of oscillations, the wave scattering problem can be transformed into a problem with initial Cauchy data in such a way that the corresponding inverse problem can be solved by the visualization algorithm. This is illustrated by specific examples, but it is noted that the inverse problems examined in the article are solved only on the assumption that singly scattered waves are involved; allowance for multiple waves considerably complicates the problem. These difficulties are examined and suggestions for overcoming them are presented. Figures 2; references 14: 11 Russian, 3 Western.

[156-5303]

UDC 550.341

## RESOLUTION OF SEISMIC METHODS

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 2, Feb 81 manuscript received  
18 Jun 79 pp 138-146

KREMLEV, A. N., Institute of Geology and Geophysics, Siberian Department of the  
USSR Academy of Sciences

[Abstract] So-called migration methods for the processing of seismic data are being vigorously developed. The basis for such methods is approximate procedures for in-depth continuation of the wave field reflected from inhomogeneities in the medium and registered at the surface. The intensity of such a field is identified at each point with the reflectivity of the medium and thus the field performs some visualization of the investigated feature. This has afforded a significant possibility for increasing the resolution of seismic methods. In this article for the visualization of radiating objects the author has obtained a precise regularized solution of the problem of continuing the wave field in a plane in the direction of a source. An evaluation of the regularization error as a function of the regularization parameter is presented. Upward evaluations are presented of the necessary accuracy in measuring the wave field and the dimensions of the aperture for the desired level of the resolution value. It is shown that there is a fundamental possibility for increasing the classical resolution limit. A constructive algorithm is proposed which makes it possible to obtain superresolution when there is a sufficiently large aperture and adequate accuracy in field measurement, at least for linear features.

References 13: 12 Russian, 1 Western.

[156-5303]

UDC 550.837:551.25:553.982

## METHODS EMPLOYED AND RESULTS OF ELECTRIC PROSPECTING STUDIES OF TECTONICS IN NORTHERN KAMCHATKA

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 1, Jan 81 manuscript received  
16 May 79 pp 118-126

MOROZ, Yu. F., Eastern Geophysical Trust, Irkutsk

[Abstract] Kamchatka may have large reserves of petroleum and gas, but its geological study is extremely inadequate. Until recently there were virtually no data concerning the structure of the deep horizons of Mesozoic-Cenozoic strata, of the greatest interest for petroleum and gas. This dictates a major expansion of geophysical work for finding and studying promising structures. However, the use of gravity anomalies for estimating the thickness of Cenozoic formations is hindered by the lack of data from deep seismic sounding, deep drilling and seismic prospecting

and the nonuniformity of the pre-Cenozoic basement. The use of seismic prospecting by the refracted waves method is impeded by its high cost and low productivity, difficulty of orographic conditions, variability of velocities, and other factors. These factors have dictated the need for introducing electrical prospecting methods since they have sufficiently high mobility, geological and economic effectiveness. The article discusses the use of electric prospecting by the telluric currents method, magnetotelluric sounding and vertical electric sounding and the procedures for interpretation of each method and a combination of these methods for solving structural problems under the complex conditions prevailing on Kamchatka. Details are given on the thickness of Cenozoic and Mesozoic-Cenozoic formations obtained by these electric prospecting methods. Structural maps of the surface of the pre-Cenozoic basement of Northern Kamchatka and the Amanino-Voyampol'skoye interfluvium of Western Kamchatka were compiled. The relief of the surface of the metamorphosed basement was studied in individual regions. The proposed method was used in providing the background for the deep drilling of a series of structures in Western Kamchatka. Figures 3; references: 10 Russian.

[139-5303]

UDC 550.831

#### EVALUATING THE RELIABILITY OF INTERPRETATION OF GRAVITY ANOMALIES BY THE VARIABLE-DENSITY PRISMS METHOD

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 4, Apr 81 manuscript received  
24 Jul 79 pp 119-125

[Article by T. V. Balk, Siberian Electrotechnical Institute, Siberian Department,  
USSR Academy of Sciences, Irkutsk]

[Abstract] Since inverse problems in gravity are characterized by exceptional ambiguity and instability, the author stresses the need for departure from classical methods for solving such problems and proposes a stable method for solution of the linear problem in gravimetry for a model of field sources in the form of a set of homogeneous bodies (prisms). The proposed approximation method differs fundamentally from the classical method in that no attempt is made to find the true distribution of masses (all the parameters of the model of the geological object). Instead, it is only necessary to find some functionals of these masses. The problem essentially involves finding a system of functionals stably determined and having a graphic and meaningful geological interpretation and formulation of effective computation methods for defining such a system of functionals. The author has succeeded in solving these problems and shows that employing quantitative analysis methods it is possible to accomplish the following: 1) evaluate the maximum admissible accuracy in solving the inverse problem with different relationships between the real noise level in the field and the noise level stipulated by the interpreter; 2) study the influence of uncertainty in the choice of the function describing the background, the choice of the number of free parameters of this function and also

their limiting values on the accuracy of interpretation; 3) define effective ways to increase the reliability of the results of solution of inverse problems, making it possible to combine the gravimetric prospecting method with other geophysical methods and interpret different elements of the gravity field (such as  $\Delta g$  and  $V_{zz}$ ). An example of application of the proposed method is given. Table 1; references: 6 Russian.

[186-5303]

UDC 550.831

#### EXPERIENCE IN COMPUTING SPECTRAL DENSITY OF UPPER FREQUENCIES OF A GRAVITY ANOMALY USING A BUTTERWORTH FILTER

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA in Russian No 3, Mar 81 pp 138-142

MUKSUNOV, I. Kh., Moscow State University

[Abstract] The commonly used method for computing nonrecursive filters involves a replacement of a weighting function of infinite duration by a weighting function of finite duration. However, such a truncation of the weighting function results in an undesirable pulsation of the frequency characteristic. These pulsations can greatly distort the spectrum if the amplitude of the harmonics to be determined is small, as is characteristic for the spectrum of upper frequencies of a gravity anomaly. For that reason there is need for a filter close in its properties to an ideal filter with a rectangular frequency characteristic. One such filter is a particular case of a Butterworth filter, which sharply reduces the troublesome pulsations. The practical application of this filter in study of a gravity anomaly is illustrated. Spectra are shown before filtering, after filtering and after correction. The described correction makes it possible to join the low-frequency part of the spectrum with the high-frequency part, obtained by different computation methods, with an error in the transition zone not exceeding 10%. The described digital Butterworth filter in a nonrecursive form can be used in computing spectral density in the range of upper frequencies of a gravity anomaly. The need for solving this type of problem stands out very clearly when making continuous measurements of gravity when the dynamic errors of instruments distort primarily the region of upper frequencies of anomalies. Moreover, a knowledge of the spectral density of upper frequencies is necessary when determining the optimum rate of continuous profiling, in computing the admissible maximum distance between runs at sea or the distance between two parallel flight lines in an aircraft survey. Figures 3; references 5: 4 Russian, 1 Western.

[142-5303]

## LIMITS OF CORRECTNESS OF LINEAR INVERSE PROBLEMS IN GRAVIMETRY

Moscow DOKLADY AKADEMII NAUK SSR in Russian Vol 257, No 4, 1981  
manuscript received 15 Dec 80 pp 842-844

ALEKSIDZE, M. A., GVANTSELADZE, T. A. and DEKANOZISHVILI, I. V., Geophysics Institute of the Georgian Academy of Sciences

[Abstract] Assume that on the surface  $S$  of some region  $G$  one of the following 10 elements of the gravitational field is stipulated:

$$V, V_x, V_y, V_z, V_{xx}, V_{xy}, V_{xz}, V_{yy}, V_{yz}, V_{zz}, \quad (1)$$

where  $V$  is gravity potential,  $V_x$  is the potential derivative along  $x$ , etc. The  $G$  region is broken down into individual canonical bodies  $G_k$ ,  $k = 1, 2, \dots, n$ , and their density characteristics are sought in the form

$$\sigma_k(x, y, z) = a_{k0} + a_{k1}(x - x_k) + a_{k2}(y - y_k) + a_{k3}(z - z_k), \quad (2)$$

where  $a_{ki}$ ,  $i = 0, 1, 2, 3$  are coefficients and  $x_k, y_k, z_k$  are the coordinates of the "central" point of the body  $G_k$ . For expressions (1), (2) it is possible to formulate 40 direct and 40 inverse problems in gravimetry which are denoted as follows:  $(V_{xx} \rightarrow a_0)$  is termination of the vector  $a_0(a_{10}, \dots, a_{n0})$  on the basis of  $V_{xx}$  or  $(a_2 \rightarrow V_{yz})$  is determination of  $V_{yz}$  for all bodies  $G_k$  with the densities  $a_{k2}$  ( $y - y_k$ ) etc. The inverse problem will be called soluble if it is possible to find such a relationship between the height  $h_k$  and the diameter  $D_k$  of the base of a minimum cylinder  $R_k$  completely enclosing the body  $G_k$  that the corresponding inverse problem will be correct for an arbitrary geometry of the region  $G$  and any number  $n$  of bodies  $G_k$ . Soluble inverse problems play an important role in the regional interpretation of gravimetric observations when  $n$  attains several thousands. The expressions ensuring solubility of inverse problems must include not only  $h_k$  and  $D_k$ , but also the distance  $\bar{z}_k$  from the upper boundary of the cylinder  $R_k$  to the observation surface. The expression

$$D_k > f(z_k, h_k),$$

whose satisfaction ensures solubility of inverse problems, will be called the resolution of the gravimetric interpretation method. A knowledge of the resolution of the gravimetric method makes it possible, in an analysis of a gravitational model of a region, to indicate what can be obtained by a solution of the inverse problems in gravimetry and what is governed by the concepts held by the interpreter. With satisfaction of expression (5), whose derivation is given in this article, the inverse problem  $(V_z \rightarrow a_0)$  will be soluble with any number of bodies  $G_k$ . In addition, with a given number of bodies  $G_k$ ,  $k = 1, 2, \dots$ , with adherence to conditions (5),

an infinite system of equations ( $n = \infty$ ) will be entirely regular and its solution can be found by the successive approximations method. When the observation plane coincides with the upper boundary of the investigated layer, using (5) it is possible to obtain a simple expression for solubility of the inverse problem ( $V_z \rightarrow a_0$ ):  
 $D > 3/2h$ . References: 4 Russian.  
[172-5303]

UDC 550.834

#### PHYSICAL PREMISES FOR NEUTRON LOGGING WITH AN ACOUSTIC EFFECT

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA in Russian  
No 5, May 81 pp 90-100

ARKAD'YEV, Ye. A., GORBACHEV, Yu. I., KUZNETSOV, O. L., PETROSYAN, L. G. and YUSHIN, V. P., All-Union Scientific Research Institute of Nuclear Geology and Geophysics

[Abstract] An increase in the effectiveness of neutron logging can be achieved under certain conditions by acoustic effects on the investigated collectors. The discrimination of that part of the gas dissolved in the petroleum which is formed in the process of such an acoustic effect and the associated decrease in the hydrogen content of the medium can be used in detecting petroleum collectors and determining the position of the water-petroleum contact by neutron methods. The authors here examine the processes which can transpire in stratum fluids when there is an acoustic effect of this type. The article gives a thorough analysis of the conditions under which bubbles can develop, exist stably or decay in petroleum or water and their significance in analyzing the petroleum parameters of collectors. The induced cavitation and rectified diffusion phenomena are examined in detail. It is shown how the rectified diffusion and coalescence phenomena are interrelated. Since the number of gas bubbles in petroleum is many orders of magnitude greater than in water, the acoustic effects are manifested in petroleum to a far greater degree than in water. The materials analyzed by the authors indicate that the zone of effective use of the acoustic effect in neutron logging can scarcely exceed the zone of phase equilibrium, that is, the zone of pressures, temperatures and concentrations at which petroleum and gas are in equilibrium. Figures 4; table 1; references 23:  
13 Russian, 10 Western.

[192-5303]

UDC 550.834(470.63)

USE OF BOREHOLE SEISMIC PROSPECTING BY REFLECTED WAVES IN NORTHWESTERN CISCAUCASIA

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA in Russian  
No 5, May 81 pp 101-108

RUDENKO, G. Ye., KHUDZINSKIY, L. L., MIRZOYAN, Yu. D., KUTSENKO, E. Ya. and  
LOPATNIKOVA, O. A., All-Union Scientific Research Institute of Nuclear Geology and  
Geophysics

[Abstract] The combining of surface methods with borehole seismic prospecting by the reflected waves method in many cases makes it possible to increase the reliability and detail of work, but in some especially complex seismogeological conditions it is possible and desirable to make independent use of borehole seismic prospecting, as is made clear in this article. Borehole seismic prospecting by the reflected waves method was developed applicable to platform regions, but here a study is made of the applicability of the method in regions with a complex deep structure. The experimental investigations were made in northwestern Ciscaucasia for solution of the following problems: 1) testing and evaluation of the effectiveness of use of borehole seismic prospecting by reflected waves in regions with different seismogeological conditions; 2) development of methods for observations, processing and interpretation of data applicable to complex deep conditions; 3) increase in effectiveness of the method by creating special algorithms and development of a multisided program for the digital processing of data from borehole seismic observations, taking into account the characteristics at the internal points of the medium; 4) carrying out observations in areas of interest for prospecting. The observations were made in three regions differing with respect to seismological conditions: Staro-Minskaya area, transitional from a platform to a foredeep, Kaluzhskaya area, adjacent to the southern margin of a downwarp and the Labinskaya area, in a downwarp. Observations were made in encased boreholes with a depth to 2000 m and in uncased holes with a depth to 500 m. Details are given concerning each of these work variants. The results revealed that borehole seismic prospecting by reflected waves made it possible to obtain virtually identical, and in individual sectors more detailed data than when using the generally employed common deep point method. Such results were obtained using records from individual instruments merely by lowering a probe into a borehole, whereas in the processing of data by the common deep point method it was necessary to employ elaborate procedures. Effective results were obtained with lowering the probe to a depth of 300-400 m. Therefore, in areas with seismogeological conditions close to the Labinskaya and Kaluzhskaya areas the use of borehole seismic prospecting is desirable as a complement to observations with the common deep point method in order to confirm data obtained by the latter and to make such information more detailed. This can be done in sectors where boreholes have been or are being drilled. Figures 3; references: 8 Russian.

[192-5303]

UDC 550.831

NECESSARY CONDITIONS FOR SOLUBILITY OF THE TWO-DIMENSIONAL INVERSE PROBLEM IN  
GRAVIMETRY

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 5, May 81  
manuscript received 4 Jul 80 pp 54-56

CHEREDNICHENKO, V. G., Novosibirsk Institute of Soviet Cooperative Trade

[Abstract] The author has ascertained the necessary conditions for solubility of the two-dimensional inverse problem in gravimetry for bodies with a constant density. It is proposed that the gravitational field be stipulated by means of a function of a complex variable  $U(z)$  having the form of the sum of a finite number of terms of a series in inverse powers of  $z$ . The theorem for the necessary solubility condition is defined and it is shown how this theorem can be proved. The conditions are stipulated in the form of limitations on the coefficients of the  $U(z)$  function. By adherence to these conditions it is possible to achieve a more reliable and stable approximation of the measured field by functions of a particular class. A priori evaluations for solution of the inverse problem are also given in different variants. References: 6 Russian.

[191-5303]

PHYSICS OF ATMOSPHERE

UDC 551.501.7

ACOUSTIC SOUNDING OF THE ATMOSPHERIC BOUNDARY LAYER

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 257, No 5, 1981  
manuscript received 1 Sep 80 pp 1092-1096

ZUYEV, V. Ye., corresponding member, USSR Academy of Sciences, KRASNENKO, N. P.,  
FEDOROV, V. A. and FURSOV, M. G., Institute of Atmospheric Optics, Tomsk Affiliate  
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[Abstract] The monostatic acoustic sounder developed at the Institute of Atmospheric Optics is for monitoring the structure and dynamics of atmospheric processes and measuring the profile of the radial component of wind velocity. The sounder includes a receiver-transmitter with a parabolic antenna having a diameter of 1.5 m placed in a sound-absorbing cone 2 m high for protection against ambient noise, as well as a system for processing and registering data created on the basis of microprocessors and an "Elektronika-60" minicomputer which on a real time scale makes it possible to ascertain the wind velocity profile. Calibration of the sounder receiving channel by a harmonic signal with a random phase indicated that the absolute measurement error increases with an increase in wind velocity, but in the range of velocities up to 10 m/sec the mean square error does not exceed 0.3 m/sec. The operating range at the fundamental working frequency of 1 KHz is up to 1 km, the spatial resolution is 10 m and the temporal resolution is 6 sec. The signal recorder used is a facsimile recorder in which the degree of blackening of the electrochemical paper is proportional to the amplitude of the received signal and also to temperature fluctuations. This makes possible, at a real time scale, the graphic tracing of the processes of formation, destruction and movement of temperature inhomogeneities in the atmosphere with a precise tie-in of these processes in time and height. Samples of measurements are illustrated, for example, the presence of reflecting layers in the atmosphere in the altitude range from 150 to 350 m, characteristic of temperature inversions. The dynamics of the inversions could be easily traced. This and other examples show that acoustic sounding methods have extensive possibilities in meteorology and studies of boundary layer structure. Figures 2; references 5: 4 Russian, 1 Western.

[181-5303]

UDC 551.521.32:551.510.41:551.58

INFLUENCE OF SOME SMALL GAS COMPONENTS ON THE ATMOSPHERE RADIATION REGIME IN THE INFRARED RANGE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 4, Apr 81 manuscript received 17 Aug 79, after revision 29 Aug 80  
pp 384-391

ROZANOV, Ye. V., TIMOFEYEV, Yu. M. and FROL'KIS, V. A., Main Geophysical Observatory and Leningrad State University

[Abstract] An algorithm was formulated for computing the radiation gains and losses of heat in the infrared spectral range for a multicomponent molecular atmosphere. The outlines of the algorithm are presented. This is followed by an analysis of the influence exerted on radiation characteristics by small gas components in the atmosphere ( $\text{CH}_4$ ,  $\text{NH}_3$ ,  $\text{N}_2\text{O}$ ,  $\text{HNO}_3$ ,  $\text{CF}_2\text{Cl}_2$ ,  $\text{CFC}_1_3$ ,  $\text{CO}$ ,  $\text{NO}$ ,  $\text{CF}_4$  and their combinations) with respect to their present-day and predicted concentration levels. The most important small gas components, allowance for which is necessary in the radiation components of numerical models of the atmosphere, are determined. All these components can be divided into three groups. Those in group A include components which must be taken into account not only with a possible increase in their concentration in the future, but also with their present-day atmospheric content. Group B includes those which need not be taken into account with their present concentrations, but which will be significant with the predicted increase in their concentrations. Group C includes those components whose influence is small even at the predicted levels of their future concentration. Group A includes not only  $\text{H}_2\text{O}$ ,  $\text{CO}_2$  and  $\text{O}_3$ , but  $\text{CH}_4$  and  $\text{N}_2\text{O}$  as well; group B includes  $\text{CFC}_1_3$  and  $\text{CF}_2\text{Cl}_2$ ; group C includes  $\text{NH}_3$ ,  $\text{HNO}_3$ ,  $\text{NO}$  and  $\text{CO}$ . Using the Budyko semiempirical formula it was possible to compute the greenhouse effect associated with changes in atmospheric composition. Tables 4; references 26: 9 Russian, 17 Western.

[177-5303]

UDC 551.521.14

COMPUTATION OF THE FIELD OF SHORT-WAVE RADIATION AT THE BOUNDARIES OF THE CLOUDLESS ATMOSPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 4, Apr 81 manuscript received 3 May 79, after revision 14 Mar 80  
pp 373-383

GAVRILOVA, L. A., Leningrad State University

[Abstract] In an earlier study ("Ambartsumyan Functions for a Cloudless Atmosphere in the Case of Isotropic Scattering," IZV. AN SSSR, FAO, Vol 15, No 1, pp 110-114, 1979) the author presented methods for computing the Ambartsumyan functions for an isotropically scattering atmosphere with real vertical profiles of the coefficients of scattering and absorption by molecules and aerosol. By a comparison of the results of computations for such a model and a corresponding averaged homogeneous

model it was established that in individual cases a sufficient accuracy can be obtained by using a model of a homogeneous atmosphere. Continuing this line of investigation, the author has clarified the role of a vertical atmospheric inhomogeneity in the case of real optical properties. Methods are given for computing the Ambartsumyan functions for elongated scattering functions and the possibility of using them for solving some problems in atmospheric optics is discussed. The light scattering function is represented by a finite number  $N$  of terms in an expansion in Legendre polynomials. The determined values of the Ambartsumyan functions are used in computing the illumination of the underlying surface, atmospheric albedo and the radiant energy flux. The influence of atmospheric inhomogeneity and also the  $N$  number on the computation results is also analyzed. Approximate formulas are derived for these parameters. On the basis of precise solutions it was possible to evaluate the error arising with the use of these formulas. Figures 7; references: 8 Russian.

[177-5303]

UDC 551.521:551.574.13

#### RADIATION CHARACTERISTICS OF ICE CLOUDS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 4, Apr 81 manuscript received 31 Mar 80, after revision 28 Jul 80  
pp 437-439

PAVLOVA, L. N., PETRUSHIN, A. G. and TARASOVA, T. A., Institute of Experimental Meteorology and Institute of Physics of the Atmosphere

[Abstract] Data presented in an earlier paper (O. A. Volkovitskiy, et al., IZVESTIYA AN SSSR, FAO, Vol 16, No 2, pp 156-163, 1980) on measurements of the scattering function in a crystalline medium differ in different cases by  $\pm 30\%$ , which is attributable to the influence of the form, size and orientation of the crystals. The measurements were made with a scattering angle  $\psi > 10^\circ$ . Diffraction theory was used in computations with  $\psi < 10^\circ$ . The "mean cosine" of scattering, determined as

$$\bar{\mu} = \frac{\int_0^{\pi} Y(\psi) \cos\psi \sin\psi d\psi}{\int_0^{\pi} Y(\psi) \sin\psi d\psi}$$

( $Y(\psi)$  is the scattering function) was equal to 0.85-0.92. However, there is basis for assigning diffracted light with  $\psi < 10^\circ$  to direct light; then, according to measurements,  $\mu_{cr} = 0.7-0.84$ . For this case a table gives the results of computations of albedo and transmission of a cloud layer with  $\bar{\mu} = 0.8$ . The article gives the

results of computations of albedo A and transmission T of homogeneous cloud layers. The computation method used was the  $\delta$ -Eddington approximation. The computations were made with a vertical position of the sun with  $\bar{\mu} = 0.8, 0.85$  and  $0.92$  with a set of variable parameters. The table shows that due to differences in  $\bar{\mu}$  in the range  $0.85-0.92$  with the same  $\tau$  and  $\omega$  the albedo of water and crystalline clouds can differ by a factor not greater than 2; there can be cases  $A_{cr} > A_{drop}$  and vice versa, although  $\tau_{cr}$  is usually less than  $\tau_{drop}$ . Clouds of an identical geometrical thickness reflect differently due to differences in scattering capacity in the absence of absorption. When absorption is present the dependence on  $\tau$  ceases to be significant ( $\tau$  is optical thickness). Due to a difference in  $\sigma$  identical absorption causes different effects. Industrial aerosol makes a substantial contribution to absorption in a cloud in visible light. The presence of industrial aerosol increases the difference in reflectivity of water and crystalline clouds, attenuating the dependence of A on elongation of the scattering function and on  $\tau$ . Table 1; references 10: 6 Russian, 4 Western.

[177-5303]

UDC 551.521.3:551.593.52

#### EXPERIMENTAL DATA ON THE INDICES OF ATTENUATION IN THE TROPOSPHERE AND STRATOSPHERE IN THE SPECTRAL REGION $0.4-5.0 \mu\text{m}$

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 4, Apr 81 manuscript submitted 17 Dec 79, after revision 19 May 80  
pp 429-433

KISELEVA, M. S., RESHETNIKOVA, I. N. and FEDOROVA, Ye. O.

[Abstract] In the development of spectroscopic investigations of the composition of atmospheric gases from balloons the authors in other studies (see IZVESTIYA AN SSSR, FAO, Vol 11, No 7, pp 696-704; Vol 14, No 4, pp 446-454, 1978) studied the optical properties of aerosol in the troposphere and stratosphere in the visible and IR spectral regions. Measurements of solar spectra under pre-sunset conditions were made during the drifting of balloons at altitudes of about 30-32 km. These measurements made it possible to achieve a considerable increase in the contrast and response of the spectral method and yielded new information on the optical properties of the atmosphere to altitudes 28-30 km. For the first time data were obtained on the vertical profiles of the indices of attenuation of atmospheric air in the IR-region transparency windows. Continuing the publication of these observations, the authors here give data obtained for the Ryl'sk region in the region  $0.4-5.0 \mu\text{m}$ . A study was made of 16 parts of the spectrum situated in the region of the transparency windows, of which eight were in the visible range and eight were in the IR region. The experimental data were obtained in summer on the basis of the results of 11 flights of an automatic multichannel solar spectrometer in balloons. The spectrometer ensured scanning of solar radiation with a resolution

$\Delta\lambda = 0.01-0.02 \mu\text{m}$  and also continuous registry of the intensity of solar radiation in individual parts of the spectrum. The measurements were made during the ascent of the instrument and during its drift at a maximum altitude with changing solar altitudes. Figure 1 illustrates the change in the intensity of solar radiation with time for  $\lambda = 0.74 \mu\text{m}$  on 19 July 1974; Fig. 2 shows vertical profiles of the attenuation indices for  $\lambda = 0.74$  and  $\lambda = 2.20 \mu\text{m}$ ; Fig. 3 shows the spectral dependences of the attenuation indices for the region  $0.4-5.0 \mu\text{m}$  for  $H = 5 \text{ km}$ ; Fig. 4 gives the spectral dependences of the atmospheric attenuation indices in the region  $0.4-5.0 \mu\text{m}$  for  $H = 20 \text{ km}$ . These data are analyzed and compared with data from other investigations. Figures 4; references 11: 10 Russian, 1 Western. [177-5303]

UDC 551.596:551.511.32

## MODULATION INSTABILITY OF SLIGHTLY NONLINEAR ACOUSTIC AND INTERNAL GRAVITATIONAL WAVES PROPAGATING HORIZONTALLY IN THE OCEAN

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 4, Apr 81 manuscript received 6 Aug 79 pp 428-429

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[Abstract] Nonlinear internal gravitational waves have been investigated in a number of studies, but only for the long-wave dispersion region (small wave numbers) and for short waves with  $k_z \neq 0$ . Accordingly, the authors investigate slightly nonlinear acoustic and internal gravitational waves propagating horizontally ( $k_z = 0$ ) along the x-axis with the group velocity of a linear wave. Such waves can be excited in the atmosphere due to perturbation present in the upper layers. Using as a point of departure the ordinary hydrodynamic equations for a plane nonrotating earth, a system of nonlinear equations is derived by the perturbations theory method making it possible to ascertain the conditions of instability for waves of a constant amplitude. The conditions for wave instability relative to longitudinal and transverse long-wave perturbations are established. These conditions were investigated both analytically for asymptotic  $k$  values and numerically on a computer. It was found that internal gravitational waves are unstable to longitudinal perturbations when the wave number is limited from below  $k > k_{g1}$  and unstable to transverse when  $k < k_{g2}$ . With respect to acoustic waves, in the interval of wave numbers  $k_{a2} < k < k_{a1}$  they are unstable to transverse perturbations, whereas in the interval  $k_{a1} < k < k_*$  the waves are modulationally unstable with respect to both transverse and longitudinal perturbations. When a wave is unstable to longitudinal perturbations small perturbations lead to its decay into solitones. The amplitude of a gravitational solitone is small everywhere except for wave numbers directly near  $k_{g1}$ .

A numerical study of the characteristic width of an acoustic soliton shows that the amplitude can be finite if the wave number of the acoustic wave is close to  $k_1$ .  
Figure 1; references 6.  
[177-5303]

UDC 551.591.1:551.463.5:535.36

FREQUENCY-CONTRAST CHARACTERISTIC AND SPREAD FUNCTION FOR A HIGHLY ANISOTROPIC SCATTERING MEDIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
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[Abstract] The small-angle approximation is commonly used in computing the frequency-contrast characteristic of media with a highly elongated scattering indicatrix (highly anisotropic scattering media). However, the solution for the frequency-contrast characteristic available at the present time, obtained in a small-angle approximation, relates to only one indicatrix in the special form:

$$x(\theta) \sim e^{-a\theta}/\theta, \quad (1)$$

where  $\theta$  is the scattering angle. Therefore, still using the small-angle approximation, formulas are derived for describing the frequency-contrast characteristic for media with an arbitrary (but adequately highly elongated) scattering indicatrix. In deriving such formulas it is better to stipulate the scattering indicatrix in the form:

$$x(\theta) = \sum_n A_n e^{-a_n \theta}. \quad (2)$$

The stipulation of the indicatrix in the form (2), in contrast to (1), makes possible a more precise allowance for scattering at great angles and also a more precise description of the function  $S(\omega)$  (the Fourier transform of the spatial distribution of illumination  $E(r)$  from a point monodirectional source in a scattering medium). This makes it possible to obtain the totality of moments for the spread function for media with an arbitrary scattering indicatrix. The solutions provided can also be used in describing the light field in a medium with illumination of the medium by a source with some initial distribution of illumination  $E_0(r)$ .

Figures 2; references: 11 Russian.

[193-5303]

UDC 551.46.072:551.463.5;535.361

LABORATORY INVESTIGATION OF THE AXIAL BRIGHTNESS OF A LIGHT BEAM OF FINITE DIMENSIONS PROPAGATING THROUGH A SCATTERING LAYER

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
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pp 551-554

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[Abstract] The overwhelming majority of studies of multiple light scattering have been made for the case of illumination of the medium by a quite broad light beam. Such conditions do not always prevail. For this reason it was important to determine the correlation between the characteristics of scattered radiation and the cross-section of the illuminating beam and the author accordingly made an experimental investigation of the influence of the illuminating beam on the brightness of the radiation propagating through a plane layer of the scattering medium and along the axis of the incident beam (that is, with a scattering angle  $0^\circ$ ). The measured parameter was the brightness coefficient  $\beta(0^\circ)$  in the geometric zone of the illuminating beam with a wavelength  $\lambda = 550$  nm. The measurements were made with previously described apparatus with quite great optical thicknesses of the scattering layers. The aperture angles of the illuminating beam and the detector were 4 and  $5^\circ$  respectively. The investigated objects were plane-parallel layers of light-scattering glasses of different thicknesses. Absorption in the investigated glasses was small and the probability of survival of a photon in them was not less than 0.99. In this study an investigation was made only of the brightness of the radiation emanating from the layer (and not within the scattering medium). The investigated objects had Fresnel glass-air discontinuities. The optical section was  $Q = \pi/4(\epsilon d)^2$  ( $\epsilon$  is the index of attenuation of the scattering medium,  $d$  is the diameter of the illuminating beam) (it varied in the range  $28 \leq Q \leq 29 \cdot 10^6$ ). The experiments indicated a substantial influence of the diameter of the illuminating beam on the axial brightness of the transmitted radiation and a complex character of the dependence itself, determined both by the optical thickness  $\tau$  of the scattering layer and by the optical section  $Q$  of the illuminating beam. Figures 5; references: 8 Russian.

[193-5303]

LASER SOUNDING OF THE ATMOSPHERIC HUMIDITY PROFILE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 6, 1981  
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[Abstract] One of the most promising methods for remote determination of the gas structure of the atmosphere, including its humidity, is the laser sounding method based on scattering phenomena and resonance absorption of radiation. However, in practical application of the method a number of complex problems arise which have now been solved by the authors: 1) an informative spectral interval was selected which is optimum with respect to lidar energy potential; 2) the evolution of the contour of the working absorption line of  $H_2O$  molecules was studied for the conditions prevailing in the real atmosphere; 3) an effective algorithm was formulated for interpretation of experimental data with the use of smoothing splines; 4) an original instrumentation complex was created and a sounding method was developed. The article, however, emphasizes the results of lidar sounding of absolute tropospheric humidity obtained in the Tomsk area in the summer of 1978 at nighttime under stable anticyclonic conditions; radiosonde humidity profiles are given as a comparison. It is shown that the results obtained by independent methods agree satisfactorily with one another. It is clear that lidar determinations of humidity to an altitude 9-10 km are of a sufficiently high accuracy (humidity profiles were obtained to an altitude 17 km). However, the error for altitudes > 10 km attained or even exceeded the value of the measured parameter as a result of the low water vapor concentrations at these altitudes. Nevertheless, even with such an error level the lidar profiles were close to the radiosonde profiles. However, it is believed that these errors can be decreased by an increase in the volume of the sample of echo signals, an increase in the energy potential of the transmitter and lidar response. It is concluded that in comparison with the radiosonde method the lidar method has a high spatial resolution and an adequate measurement accuracy; it makes it possible to obtain more routine data on humidity, which is important in investigations of the dynamics of processes determining water vapor transfer in the atmospheric boundary layer; it makes it possible to determine the humidity distribution in the entire thickness of the troposphere and lower stratosphere.

Figure 1; references 11: 10 Russian, 1 Western.

[197-5303]

ARCTIC AND ANTARCTIC RESEARCH

UDC 551.510.536

LASER SOUNDING OF THE UPPER ATMOSPHERE AT THE ANTARCTIC STATION MOLODEZHNAЯ

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 258, No 2, 1981  
manuscript received 29 Sep 80 pp 334-335

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[Abstract] Systematic experiments with laser sounding of the upper atmosphere in the south polar region were initiated in May 1979 at the Antarctic station Molodezhnaya in accordance with the national program for investigating the middle atmosphere. The objective of the work was a study of dynamic processes for measuring the concentration and vertical distribution of the sodium layer in the Antarctic mesosphere during the polar night. Sounding was with a lidar with an emission line width of  $0.1 \text{ \AA}$ . The surface antenna was a telescope with a receiving surface 80 cm in diameter and an angle of the field of view  $5 \cdot 10^{-3} \text{ rad}$ . A photodetector operated in a photon-counting regime. Data for the period May-October indicated that the sodium concentration in the south polar region  $69^\circ\text{S}$  is influenced by a series of dynamic processes. The observed vertical distribution frequently drops sharply in an extent of 3-5 km due to the influence of turbulent diffusion. The turbulence coefficient, computed on the basis of the nature of change in the concentration with altitude, corresponds to values characteristic for the middle latitudes. The mean altitude of the layer is  $91 \pm 1 \text{ km}$ . The dynamics of the upper part of the layer at an altitude of about 100 km and the sodium concentration in a column are probably due to the influence of meteor streams. The considerable stratification in the distribution with a width of the layers  $\sim 1 \text{ km}$ , in which the concentration substantially exceeds the mean value, indicates the presence of atmospheric disturbances specific for the auroral zone, such as due to the leakage of high-energy particles. It was possible to detect traveling gravitational waves with periods of 12, 8, 6, 4, 3 km, etc. There is a change in the phase of waves with velocities 0.6-3 km/hour, propagating both downward and upward, indicating a different nature of their excitation sources.

[196-5303]

## SCIENTIFIC RESEARCH ICEBREAKER STUDIES KARA SEA

Moscow ZNANIYE-SILA in Russian No 4, Apr 81 pp 10-11

[Interview with Z. Gudkovich, doctor of geographical sciences, Arctic and Antarctic Scientific Research Institute, by Z. Kanevskiy: "Laboratory Floats in the Ice"]

[Abstract] The scientific research icebreaker "Otto Shmidt," the country's first such vessel, undertook its first voyage in the Kara Sea in the autumn of 1979. The objective was a study of the processes transpiring during the period of intensive ice formation in late October-November. This was the first time that such observations had been made in the Kara Sea so late in the year. The program provided for observations while the ship was proceeding on course and during stops for making multisided oceanological investigations, but also prolonged measurements made while at drift. The ship is relatively small, having a displacement of about 4,000 tons. It can carry 30 scientific specialists, representatives of the Murmansk Hydrometeorological Service and the Arctic and Antarctic Scientific Research Institute. All parts of the vessel were specially designed for facilitating hydrometeorological and ice observations: laboratories, apparatus, instrumentation. Ice and other samples can be analyzed on board immediately. A special shaft in the ship's hull makes it possible to lower instruments directly into the sea when the vessel is enclosed by ice masses. This shaft, with a diameter of about 80 cm, is suitable for the lowering of bathometers and current meters. The "Otto Shmidt" is not exceptionally powerful and cannot operate in heavy ice. It is suitable for young, smooth autumn ice up to a half-meter in thickness or in thin summer ice of marginal seas. A question of considerable current interest is the extent to which the Kara Sea would be affected by the shifting of the runoff of a number of northern rivers to the south, with the resulting lessening of fresh-water runoff into the Kara Sea. It has been concluded that the heat content of this runoff exerts no significant effect on the regime of the Kara Sea. The principal influence exerted by Siberian rivers is the freshening effect. Any change in the runoff volume would invariably have an effect on salinity and salinity governs the times of freezing of sea water and the associated growth of ice. Since saline water freezes at a lower temperature than fresh water, a lessening of fresh-water runoff would result in the later freezing of the sea and a lesser growth of ice. Salinization of surface waters causes more active mixing and this would cause more intensive entry of heat from the deep layers into the surface layers. The quantity of ice would therefore decrease. On the other hand, the lessening of river runoff would reduce the transport of Kara ice because the powerful rivers, pouring into the sea, participate in creating a system of currents which carry the ice away. However, according to calculations made at the Arctic and Antarctic Scientific Research Institute using a mathematical model these different effects should mutually compensate one another. With the currently proposed volumes of southward shifting of runoff there should be no significant changes in the ice regime of the Kara or other arctic seas; if hundreds of cubic kilometers per year were involved, the consequences could be extremely serious. Figures 2.

[194-5303]

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